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Effect of integrated nutrient management on growth parameter of tomato

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Abstract
The present investigation entitled "Effect of integrated nutrient management on growth parameter of tomato" was conducted at the Horticultural Research cum Instructional Farm, IGKV, Raipur (C.G.) during *Rabi* season 2021-22 and 2022-23. The experiment was laid out in randomize block design with three replications and twelve treatments *i.e.* T_1 : Control, T_2 : 50% RDF, T_3 : 75% RDF, T_4 : 100% RDF, T_5 : 50% RDF + 50% FYM , T_6 : 50% RDF + 50% Vermicompost, T_7 : 50% RDF + 50% FYM + PSB, T_8 : 50% RDF + 50% Vermicompost + PSB, T_9 : 75% RDF + 25% FYM, T_{10} : 75% RDF + 25% Vermicompost, T_{11} : 75% RDF + 25% FYM + PSB and T_{12} : 75% RDF + 25% Vermicompost + PSB. The result of present study revealed that the growth parameters *viz*., plant height (cm), number of primary branches plant^{-1}, number of secondary branches plant^{-1}, number of nodes to first flowering, days to 50% flowering, number of flower per cluster per plant were significantly influenced by application of 75% RDF + 25% Vermicompost + PSB.

Keywords: Integrated nutrient management, Tomato, Growth parameter, Vermicompost, Phosphorus solubilizing bacteria

Introduction

Tomato (*Lycopersicon esculentum* Miller) is one of the most important vegetable crops grown throughout the world under field and greenhouse conditions (Kaloo, 1986) [1]. It is also known as poor man apple. It is herbaceous annual which is sexually propagated by seed. It is used as oil and in the manufacture of margarine. It is grown in small home gardens and market gardens for fresh consumption as well as processing purposes. Tomatoes are used directly as raw vegetables in sandwiches, sliced, and salad etc. and several processed products like paste, puree, soup, juices, ketchup, drinks, dried, whole peeled tomatoes, sauces, and chutneys are prepared on large scale. The pulp and juice are digestible, a promoter of gastric secretion and blood purifier (Musa *et al*., 2007) [2]. Lycopene is an antioxidant the most common form of carotenoid, the latter being responsible for the red color in the fruit, which markedly reduces the risk of prostate cancer that, once absorbed by the body, helps prevent and repair damaged cells (Kucuk, 2001) [3]. Tomato and its products are used as preventive strategies against some diseases such as cancer and cardio vascular diseases (Adam *et al*., 2005) [4]. Consumption of tomato and its products can significantly reduce the risk of developing of colon, rectal, and stomach cancer.

Nutritive value varies in different cultivars depending upon the agro-climatic condition. It is also rich in nutrients and calories. It is a good source of Fe and vitamin A, B, and C. Edible portion of tomato per 100 g contain energy (18 kcal), protein (0.95 g), fat (0.11 g), carbohydrate (4.01 g), total sugars (2.49 g), calcium (11 mg), iron (0.68 mg), magnesium (9 mg), phosphorus (28 mg), potassium (218 mg), sodium (11 mg), Zn (0.14 mg), vitamin A (1100 I.U) vitamin C (22.8 mg), thiamin (0.036 mg), riboflavin (0.022 mg), vitamin B6 (0.079 mg), vitamin E (0.56 mg), lycopene (20-50 mg), titratable acidity (7.5-10 mg/100 ml), total solids (4-7 %), fibers (0.6 g), total saturated fatty acids (0.015 g) and total polyunsaturated fatty acids (0.044 g) (Anonymous, 2013).

In India, tomato is cultivated in almost all parts of country. Tomato ranks first among the processed vegetables. It is a very good source of income to small and marginal farmers. It is grown in an area of 86.5 million hectares, production 210.56 million tonnes with the productivity of 24.34 MT/ha. Major tomato producing state are Madhya Pradesh, *Odisha* Tamilnadu, *Karnataka*, Andhra Pradesh, Chhattisgarh, Maharashtra, West Bengal, Bihar and Gujrat (Anonymous, 2021) [5]. In Chhattisgarh, it is grown in an area of 6.13 million hectares, production 106.20 million tonnes with the productivity of 17.30 MT/ha. Major producing district are Durg, Jashpur, Kondagaon, Raigarh, Bilaspur, Surguja, Raipur, Rajnandgaon, Bemetara and Balod (Anon, 2022) [6].

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The main principle of integrated nutrient management is to maximize the use of organic inputs while minimizing nutrient losses and to make supplementary use of chemical fertilizers. Good practices for integrated nutrient management often involve a combination of organic and inorganic sources of nutrients. Besides sustainable agricultural production, all round improvement in physical, chemical and biological make up of soils is the main aim of INM (Chadha, 2002) [7]. Vermicompost have excellent effect on overall plant growth encourages the growth of new shoots or leaves and improves the quality and shelf life of the produce. Biofertilizers are the biologically active product and containing selective strain of micro-organism. Among the major nutrients, the phosphatic fertilizers as well as organic phosphate available in soil are less soluble and not readily absorbed by the plants. Phosphorus solubilizing bacteria (PSB) are beneficial bacteria capable of solubilizing inorganic phosphorus from insoluble compounds.

Materials and Method

The present experiment was conducted at Horticultural Research cum Instructional Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur (Chhattisgarh) during *Rabi* season 2021-22 and 2022-23 with tomato crop cultivar *Pusa* Ruby. The experiment was comprised of 12 treatment combination of recommended dose of NPK fertilizers and integrated nutrient management practices with one control. These treatments combination with their symbols are given in Table 1. The schedules of different pre and post-sowing cultural operations carried out timely during the crop season. The economic analysis *viz.,* gross profit, net profit and b:c ratio were calculated.

Results and Discussion

The data on cost of cultivation, gross returns, net returns and benefit: cost ratios as influenced by Effect of integrated nutrient management on economics of tomato. The economics of tomato cultivation under the present investigation were calculated using the prevailing cost of inputs and market rate of the produce during the respective years are shown in Table (2 & 3) and Figure (1, 2, 3, 4, 5 & 6)

Plant height at 90 DAT (cm)

The data pertaining to plant height is presented in Table 2 and illustrated in Figure 1. The statistical data revealed that the plant height at 90 days after transplanting significant difference in plant height was observed among various treatments.

Table 1. Treatments combination with their symbols.

S. No.	Symbols	Treatments
1.	T_1	Control
2.	T_2	50% RDF
3.	T_3	75% RDF
4.	T_4	100% RDF
5.	T_5	50% RDF + 50% FYM
6.	T_6	50% RDF +50% Vermicompost
7.	T_7	50% RDF + 50% FYM + PSB
8.	T_8	50% RDF + 50% Vermicompost + PSB
9.	T_9	75% RDF + 25% FYM
10.	T_{10}	75% RDF + 25% Vermicompost
11.	T_{11}	75% RDF + 25% FYM + PSB
12.	T_{12}	75% RDF + 25% Vermicompost + PSB

The significant difference was observed in plant height at 90 days after transplanting due to application of integrated nutrient management practices. The perusal data in both the year and pooled mean revealed that the plant height at 90 days after transplanting was recorded maximum in treatment T_{12} (68.66, 71.12 and 69.89 cm, respectively), which was significantly superior among all treatments but statistically *at par* with treatment T_{11} (65.92, 67.06 and 66.49 cm, respectively), T_{10} (65.87, 66.18 and 66.03 cm, respectively) and T_9 (63.88, 66.01 and 64.95 cm, respectively). However, the plant height was observed minimum in treatment T_1 (55.49, 57.02 and 56.26 cm, respectively) *i.e.* in control

This increase in height may be due to the fact that PSB promotes vegetative growth by active cell division and elongation, and therefore, the height might have increased. This might be due to application of major and minor nutrients, through different organic manure and biofertilzers, increased the photosynthetic activity, chlorophyll formation, nitrogen metabolism and auxin contents in the plants which ultimately improved the plant height. The investigation is and in agreement with the findings of Kumaran *et al.* (1998) [8], Naidu *et al.* (2002) [9], Meena *et al*. (2013) and Yadav and Pandey (2015) [10] in tomato. plant height increased also due to improvement in the physiochemical properties of soil; increase in enzymatic activity; increase in microbial population, diversity and activity; easy availability of soil macro- and micronutrients; and also increase in plant growth hormones by application of vermicompost (Albiach *et al*. 2000, Arancon *et al*. 2006, Prabha *et al*. 2007 and Azarmi *et al*. 2008) [11].

Number of primary branches plant-1 at 90 DAT

The application of different combination of RDF, organic fertilizers and PSB was differ significantly 90 days after transplanting with respect to number of primary branches plants^{-1}. The data on the mean number of primary branches plants^{-1} at 90 DAT are presented in Table 2 and depicted graphically in Figure 2.

Among the treatments, maximum number of primary branches plants^{-1} at 90 DAT was recorded in T_{12} (12.97, 14.80 and 13.89) during 2021-22, 2022-23 and in mean data, respectively. This was *at par* with T_{11} (12.34, 13.34 and 12.84), T_{10} (11.31, 13.04 and 12.17) and T_9 (11.24, 12.65 and 11.94) during 2021-22, 2022-23 and in mean data, respectively. However, minimum number of primary branches plants^{-1} at 30 after transplanting was recorded in T_1 (7.84, 8.15 and 8.00) during 2021-22, 2022-23 and in mean data, respectively.

The implementation of integrated nutrient management may have improved the physical and chemical characteristics of the soil, resulting in an adequate supply of nutrients to the plants, which may have promoted the maximum vegetative growth while the minimum plant growth was caused by nutrient scarcity. Similar findings were reported by Mahto *et al*. (2009) [12], Prabhu *et al.* (2010) [13] and Kumar *et al.* (2014) [14] in tomato.

Number of secondary branches plant-1 at 90 DAT

The data for number of branches per plant were recorded at 90 days after transplanting (Table 2 and Figure 3). It is apparent from the data that number of secondary branches per plant were significant differed at 90 days after transplanting was observed among various treatments.

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Among the treatments, maximum number of secondary branches plants^{-1} at 90 DAT was recorded in T_{12} (20.86, 23.98 and 22.42) during 2021-22, 2022-23 and in mean data, respectively. This was *at par* with T_{11} (18.52, 21.06 and 19.79), T_{10} (18.28, 20.67 and 19.48) and T_9 (17.84, 20.07 and 18.96) during 2021-22, 2022-23 and in mean data, respectively. However, minimum number of secondary branches plants^{-1} at 30 after transplanting was recorded in T_1 (11.51, 13.19 and 12.35) during 2021-22, 2022-23 and in mean data, respectively.

It was revealed that number of branch per plant tomato increased which the inorganic fertilizers, vermicompost and PSB in tomato. Similar result has also been reported by Meena *et al.* (2010) [15] and Paulraj *et al.* (1982) [16] in tomato.

Number of node to first flowering

The application of different combination of RDF, vermicompost and PSB fertilizer was found significant with respect to number of nodes to first flowering. The data on the number of nodes to first flowering are presented in Table 3 and depicted graphically in Figure 4.

Among the treatments, maximum number of nodes to first flowering was recorded in T_{12} (9.05, 9.25 and 9.15) during 2021-22, 2022-23 and in mean data, respectively. This was at par with T_{11} (8.11, 8.15 and 8.13), T_{10} (7.54, 7.76 and 7.65) and T_9 (7.35, 7.82 and 7.59) during 2021-22, 2022-23 and in mean data, respectively. However, minimum number of nodes to first flowering was recorded in T_1 (4.62, 5.14 and 4.88) during 2021-22, 2022-23 and in mean data, respectively.

Days to 50% flowering

Significant differences were exhibited among different treatments with respect to the days to 50% flowering in 2021-22, 2022-23 and pooled mean (Table 3 and Figure 5).

Among all the treatment T_{12} was recorded minimum days taken to 50% flowering (31.01, 34.52 and 32.77) which was statistically *at par* with treatment T_{11} (31.82, 35.90 and 33.86), T_{10} (33.49, 38.75 and 36.12), T_9 (34.25, 39.20 and 36.73), T_8 (34.96, 40.22 and 37.59) and T_6 (36.34, 40.34 and 38.34) in 2021-22, 2022-23 and pooled mean, respectively. While treatment T_1 reported maximum days taken to 50% flowering (43.63, 45.63 and 44.63) in the 2021-22, 2022-23 and pooled mean, respectively.

The earliness to flowering in treatment T_{12} might be due to the better translocation of nutrients to the aerial parts. The earliness in flowering could be attributed to the faster enhancement of vegetative growth and storing sufficient reserved food materials for differentiation of buds into flower buds, whereas the delayed flowering recorded by the inorganic fertilizer treatment and control could be due to extended vegetative phase of the plant by the availability of inorganic nitrogen. Similar results were also reported by Anburani *et al.* (2004) [17] in tomato. Similar findings were reported by Naidu *et al.* (2002) [9] in tomato and Prativa *et al.* (2011) [10] in tomato.

Number of flower cluster per plant

The number of flower cluster per plant was recorded in experimental period are presented in Table 3 and Figure 6. The statistical data from table revealed that the number of flower cluster per plant was significantly influenced by various treatments in 2021-22, 2022-23 and pooled mean, respectively.

The treatment T_{12} was recorded maximum number of flower per cluster per plant was recorded in (20.03, 20.83 and 20.43) during 2021-22, 2022-23 and in mean data, respectively. This was *at par* with T_{11} (18.73, 19.66 and 19.20), T_{10} (18.59, 18.23 and 18.41) and T_9 (16.24, 16.94 and 16.59) during 2021-22, 2022-23 and in mean data, respectively. However, minimum number of flower per cluster per plant was recorded in T_1 (8.45, 9.08 and 8.77) during 2021-22, 2022-23 and in mean data, respectively

Table 2. Effect of integrated nutrient management on Plant height, Primary Branch and number of secondary branch of tomato

Treatments	Plant height at 90 DAT			Primary Branch at 90 DAT			Secondary Branch at 90 DAT		
	2021-22	2022-23	Pooled mean	2021-22	2022-23	Pooled mean	2021-22	2022-23	Pooled mean
T_1 : Control	55.49	57.02	56.26	7.84	8.15	8.00	11.51	13.19	12.35
T_2 : 50% RDF	58.87	60.13	59.50	8.97	9.72	9.35	15.24	15.24	15.24
T_3 : 75% RDF	60.85	62.01	61.43	9.98	11.49	10.74	16.03	16.52	16.28
T_4 : 100% RDF	62.49	65.30	63.90	10.69	12.65	11.67	17.61	19.90	18.76
T_5 : 50%RDF + 50%FYM	59.02	61.39	60.21	9.74	10.14	9.94	15.91	15.98	15.95
T_6 : 50%RDF + 50%Vermicompost	61.04	63.78	62.41	10.27	11.51	10.89	17.37	17.33	17.35
T_7 : 50% RDF + 50%FYM + PSB	60.90	64.10	62.50	10.00	11.50	10.75	16.90	17.46	17.18
T_8 : 50%RDF + 50% Vermicompost + PSB	61.85	64.68	63.26	10.58	11.94	11.26	17.50	18.07	17.79
T_9 : 75% RDF + 25% FYM	63.88	66.01	64.95	11.24	12.65	11.94	17.84	20.07	18.96
T_{10} : 75% RDF + 25% Vermicompost	65.87	66.18	66.03	11.31	13.04	12.17	18.28	20.67	19.48
T_{11} : 75% RDF + 25% FYM + PSB	65.92	67.06	66.49	12.34	13.34	12.84	18.52	21.06	19.79
T_{12} : 75% RDF + 25% Vermicompost + PSB	68.66	71.12	69.89	12.97	14.80	13.89	20.86	23.98	22.42
SEm (±)	2.28	2.07	2.18	0.78	0.86	0.82	0.90	1.21	1.07
CV (%)	6.35	5.60	5.98	12.85	12.67	12.77	9.16	11.48	10.48
CD (p = 0.05)	6.68	6.07	6.07	2.28	2.52	2.34	2.63	3.56	3.04

(continued on next page)

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Table 3. Effect of integrated nutrient management on number of node to first flowering, days to 50% flowering and Number of flower cluster per plant of tomato

Treatments	Number of Node to First Flowering			Days to 50% flowering			Number of flower cluster per plant		
	2021-22	2022-23	Pooled mean	2021-22	2022-23	Pooled mean	2021-22	2022-23	Pooled mean
T_1 : Control	4.62	5.14	4.88	43.63	45.63	44.63	8.45	9.08	8.77
T_2 : 50% RDF	5.41	5.54	5.48	40.81	45.48	43.15	10.70	10.47	10.59
T_3 : 75% RDF	6.44	6.00	6.22	38.94	43.54	41.24	12.23	12.66	12.45
T_4 : 100% RDF	7.28	7.41	7.35	34.58	39.79	37.19	15.99	16.80	16.40
T_5 : 50%RDF + 50%FYM	6.03	5.96	6.00	39.07	44.78	41.93	11.77	11.97	11.87
T_6 : 50%RDF + 50%Vermicompost	6.80	6.11	6.46	36.34	40.34	38.34	13.00	13.20	13.10
T_7 : 50% RDF + 50%FYM + PSB	6.76	6.61	6.69	38.01	43.22	40.62	12.66	13.57	13.12
T_8 : 50%RDF + 50% Vermicompost + PSB	7.04	7.07	7.06	34.96	40.22	37.59	14.57	15.23	14.90
T_9 : 75% RDF + 25% FYM	7.35	7.82	7.59	34.25	39.20	36.73	16.24	16.94	16.59
T_{10} : 75% RDF + 25% Vermicompost	7.54	7.76	7.65	33.49	38.75	36.12	18.59	18.23	18.41
T_{11} : 75% RDF + 25% FYM + PSB	8.11	8.15	8.13	31.82	35.90	33.86	18.73	19.66	19.20
T_{12} : 75% RDF + 25% Vermicompost + PSB	9.05	9.25	9.15	31.01	34.52	32.77	20.03	20.83	20.43
SEm (±)	0.40	0.46	0.43	2.02	2.04	2.03	1.10	0.89	1.00
CV (%)	9.99	11.54	10.80	9.59	8.64	9.09	13.23	10.37	11.84
CD (p = 0.05)	1.16	1.35	1.22	5.91	5.99	5.78	3.23	2.61	2.86

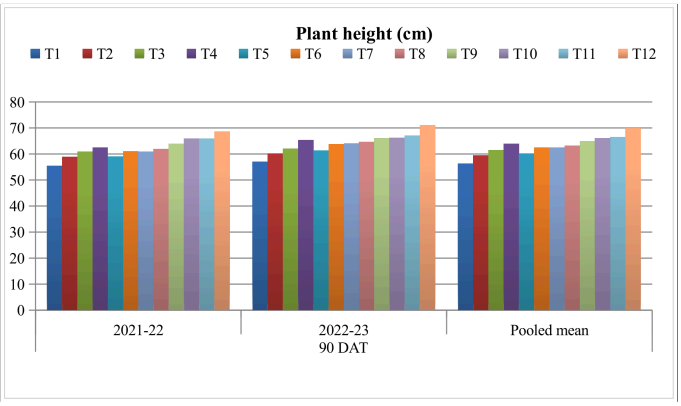


Figure 1. Effect of integrated nutrient management on plant height (cm) of tomato

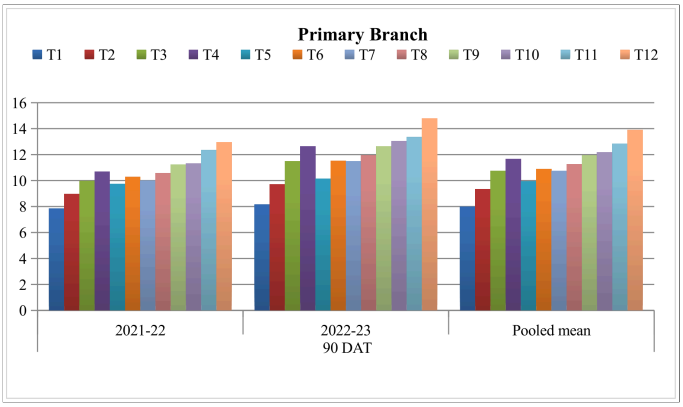


Figure 2. Effect of integrated nutrient management on number of primary branches of tomato

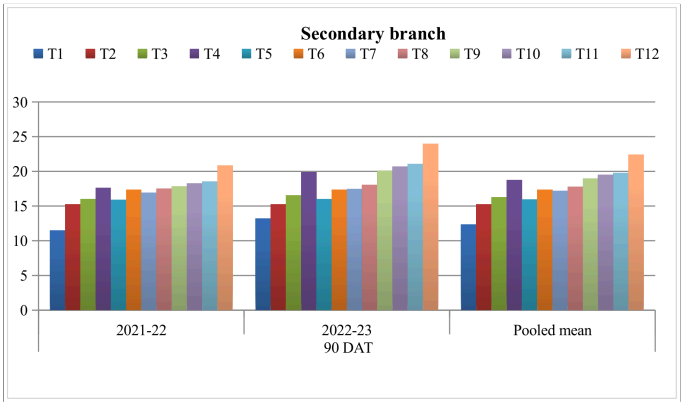


Figure 3. Effect of integrated nutrient management on number of secondary branches of tomato

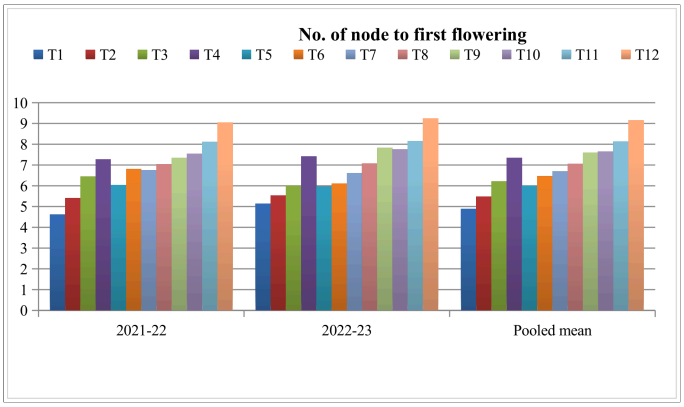


Figure 4. Effect of integrated nutrient management on number of nodes to first flowering of tomato

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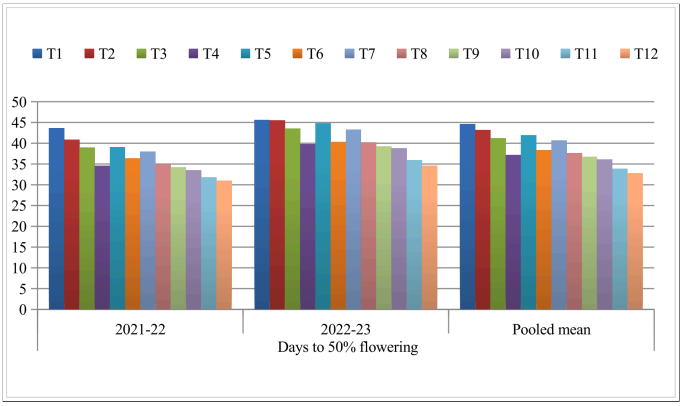


Figure 5. Effect of integrated nutrient management on days to 50% flowering of tomato

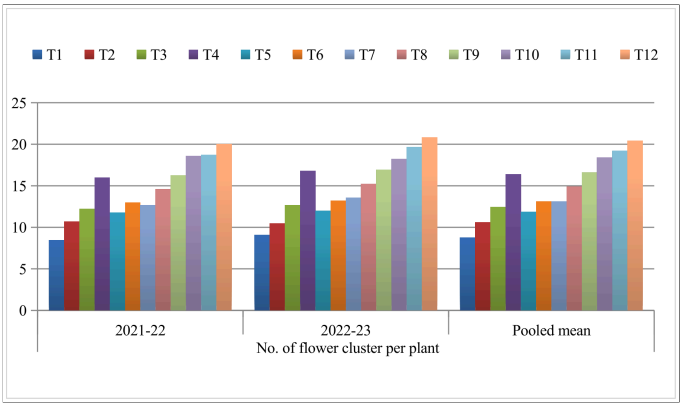


Figure 6. Effect of integrated nutrient management on number of flower cluster per plant

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